WEST AFRICAN COCOA RESEARCH INSTITUTE

QUARTERLY PROGRESS REPORT

No. 61

TAFO, GHANA.

PRINTED BY THE HAG PRESS—PRINTERS, TAFO.

WEST AFRICAN COCOA RESEARCH INSTITUTE

TAFO, GHANA

SIXTY-FIRST QUARTERLY REPORT

JANUARY - MARCH, 1961

Any results recorded in this report should not be accepted as conclusive inasmuch as the report contains interim information only. More complete results are published in WACRI Technical Bulletins and elsewhere.

SENIOR STAFF

Director	J. Lamb (on leave prior to resignation 22/2/61)
Secretary	A.F. Neale (on leave 22/2/61)
Accountant	J.N.A. Hyde (Ag. Secretary from 22/2/61)
TAFO STATION	
Division of Entomology	E. Dunn
	K.B. Armstrong
	M.R. Smith
	V. Ammah-Attoh (resigned 9/1/61)
	B.M. Gerard
Division of Pathology	J.W. Blencowe (Ag. Director from 22/2/61)
	A.L. Wharton
	P.D. Turner
	A.A.F. Brunt (returned from leave 23/3/61)
	A. Attafuah (on scholarship in U.K.)
Division of Botany	D.R. Glendinning
	R.G. Lockard
	E.J.A. Asomaning
Division of Chemistry	R.H. Kenten (returned from leave 11/1/61)
	D.K. Acquaye
Division of Agronomy	T.H.R. Hall (on leave)
	R.W. Smith
Statistician	C. de Jonge (on leave 2/3/61)
Spectrographic Speclst.	J.C. Burridge
Laboratory Technician (Electronics)	A.J.H. Arnold (secondment ended 30/3/61)
Plantation Manager	H.W.S. Allison
Asst. Plantation Manager	E.O. Quao (appointed 1/1/61)
Maintenance Engineer	G.O. Hayward (returned from leave 28/2/61)
Asst. Maint. Engineer	G.O. Amponsah
Works Superintendent	E.K. Berko
Guide-Demonstrator	F.E. Decker
Medical Officer	P.K.K. Knudsen
IBADAN STATION	
Deputy Director	T.W. Tinsley (returned from leave 28/3/61)
Secretary	H.Ll. Pugh
Entomologists	R.G. Donald
	P.F. Entwistle
	C.K.H. Martini (on leave 5/1/61)
Agronomists	J.E. Longworth
	G.H. Freeman
	M. Wessel (appointed 16/1/61)
Mycologist	E.C. Hislop (on leave 28/2/61)
Plantations Officer	W. Rides
WEST AFRICAN FUNGICIDES RESEARCH UNIT	
Chemist	P.O. Park (completion of secondment 26/1/61)

ADMINISTRATION

MANAGING COMMITTEE

The 31st Meeting of the Managing Committee was held on 13th February, 1961. It was attended by :

CHAIRMAN

J.F.G. Sykes, Esq., O.B.E.	Administrator, West African Research Office, Accra, Ghana.

MEMBERS

C.R. Henniker-Heaton, Esq.	Representing Permanent Secretary, Ministry of Economic Development, Lagos, Nigeria.
Dr. J.M. Waterston	Director of Agricultural Research (Federal), Moor Plantation, Ibadan, Western Nigeria.
Chief C.O. Taiwo	Permanent Secretary, Ministry of Agriculture & Natural Resources, Ibadan, Western Nigeria.
T.S.B. Aribisala, Esq.	Chief Agricultural Extension Services Officer, Ministry of Agriculture and Natural Resources, Ibadan, Western Nigeria.
A.E. Chinbuah, Esq.	Principal Secretary, Ministry of Agriculture, Accra, Ghana.
E. Quartey-Papafio, Esq.	Chief Cocoa Officer, Division of Agriculture, Accra, Ghana.
Sir Tsibu Darku, Kt., O.B.E.	Chairman, Ghana Cocoa Marketing Board, Accra, Ghana.
Y. Sefa-Boakye, Esq.	Member, Ghana Cocoa Marketing Board, Accra, Ghana.
J.A.C. Davies, Esq.	Ag. Deputy Director of Agriculture, Njala, Sierra Leone.
J. Lamb, Esq., O.B.E.	Director, West African Cocoa Research Institute, Tafo, Ghana.

NON-VOTING MEMBERS

W.R. Feaver, Esq., C.B.E.	Manager, Cadbury & Fry, Accra, Ghana.
S.R. Highmoor, Esq.	Manager, Rowntree-Fry-Cadbury, Lagos, Nigeria.
R.E.G. Burnley, Esq.	Ag. Principal Agricultural Officer, Buea, Southern Cameroons.
R.G. Donald, Esq.	Ag. Deputy Director (Nigeria), West African Cocoa Research Institute, Moor Plantation, Ibadan, Western Nigeria.
A.F. Neale, Esq.	Secretary, West African Cocoa Research Institute, Tafo, Ghana.

IN ATTENDANCE

P.J.D. Nesbitt-Hawes, Esq.	Deputy Administrator, West African Research Office, Accra, Ghana.
Dr. J.W. Blencowe	Senior Pathologist, West African Cocoa Research Institute, Tafo, Ghana.
J.N.A. Hyde, Esq.	Accountant, West African Cocoa Research Institute, Tafo, Ghana.

The meeting was preceded by meetings of the Technical Sub-Committee and of the Staff & General Purposes Sub-Committee.

STAFF MATTERS

The Director, Mr. J. Lamb proceeded on leave, prior to resignation, on 22nd February, Dr. J.W. Blencowe has taken over as Acting Director. Messrs. A.F. Neale, Secretary, and C. de Jonge, Statistician, proceeded on leave on 22nd February and 2nd March respectively. Mr. J.N.A. Hyde, Accountant, has been acting as Secretary, in addition to his duties of Accountant.

Mr. R.H. Kenten returned from leave on 11th January, 1961.

Messrs. G.O. Hayward and A.A.F. Brunt returned from leave on 28th February and 23rd March respectively.

Dr. T.W. Tinsley, Deputy Director, returned from leave on 28th March. Mr. W.M. Wessel, Chemist, joined the staff of the Station on 16th January, and visited Tafo, Ghana, from 25th January to 21st March. Mr. P.O. Park left Nigeria on 26th January for leave prior to returning to the East African Fungicides Research Unit at Arusha, Tanganyika. Mr. E.C. Hislop proceeded on leave on 8th February. Mr. J.F. Longworth and Dr. G.H. Freeman visited Tafo from 22nd to 27th January and Mr. R.G. Donald from 8th to 14th February.

VISITORS

The Tafo Station was honoured to receive a visit by Marshall Josip Broz Tito, President of Yugoslavia, and by Chief Kolawole Balogun, Nigerian High Commissioner to Ghana. Other visitors to Tafo included Mr. John A. Wenmohs, U.S. Agricultural Attaché to Ghana, Mr. Daniel W. Levandowskey, Horticulturalist, I.C.A., Washington, Mr. Stephen H. Carlill of the West Africa Committee, Mr. F.M. Gill of Gill & Duffus, Ltd., London, Mr. H. de B. Brock of the Eastern Regional Development Corporation, Enugu, Nigeria, Mr. Jan Brownley of Cadbury Brothers and a Team of three from the International Atomic Energy Agency.

Mr. Joseph Palmer, United States Ambassador in Nigeria visited the Ibadan Station on 20th February and the members of the U.K. Industrial Mission (Federation of British Industries) on 21st January. Other visitors included Mr. Hale, Director of Rowntree, Fry & Cadbury, two parties of four and fifty delegates respectively from the C.C.T.A. conference held in Lagos, Dr. Feuell of the Tropical Products Research Section of the D.S.I.R. and Dr. Carter of the Hawaiian Pineapple Research Station.

Dr. Blencowe, Acting Director of W.A.C.R.I. and Mr. Allison arrived from Tafo, Ghana, for short visits.

GENERAL

The new Central Stores building at Tafo has now been completed and handed over by the builders. It will be occupied and brought into use at the beginning of the new financial year. The new house at Moor Plantation, Ibadan, was completed in March and awaits connection to the electricity supply.

GAMBARI EXPERIMENTAL STATION

Acquisition: The Ministry of Lands and Housing having served the notices of acquisition gave written authority for occupation of the Station with effect from 31st January, 1961. The lease will be finalised after the disposal of claims of persons interested in the land.

Water Supply: A weir has been constructed across the River Ona at the site selected for the domestic water supply. Pumping and filter equipment on order from United Kingdom has started to arrive.

Building Sites etc. The clearing of building sites and areas to be planted continues. Approximately 12 acres of secondary forest have been clear-felled for Staff Quarters. Preparation of a further 15 acres required for establishment trials is in hand. The acquisition of a Fordson Power Major Tractor and Boughton winch has assisted considerably in the removal of felled timber. A road of approximately $\frac{3}{4}$ mile to the water supply site has been roughly constructed enabling lorry transport to operate. Areas have been cleared for plant housing and a water tower. Work on the improvement and maintenance of new and old roads is being carried out.

Nursery: Facilities now exist for the raising of 60,000 cocoa seedlings under artificial shade. A water tank of 4,800 gallon capacity has been erected on small tower and tap water is now available. Four cement beds 50 feet x 6 feet capable of containing water have been constructed to permit study of seedling growth of plants grown in pots standing in water.

General: Severe drought conditions had had considerable effect on young cocoa grown for experimental purposes. The 1957 and 1958 W.A.C.R.I. Variety Trials have suffered greatly. Watering of the affected plants has been carried out and it is thought that losses will be slight.

AGRONOMY AND PLANTATION MANAGEMENT DIVISIONS

OLD STATION FARM

Yield.

The yield in pods for the twenty-two ¼-acre plots is given in the table below.

TABLE 1

Plots	Total Pods	Diseased Pods	% Diseased
Tree recorded (5)	673	9	1.34
Plot recorded (17)	1,104	17	1.54
Total (22)	1,777	26	1.46
December Quarter	23,842	1,276	5.35

The gross yields from the Old Station are given in table 2.

TABLE 2

Period	Amelonado	Amazon	Mixed	Hybrids	Mature	Total
January	8,084	-	3,228	-	47,151	58,463
February	1,554	-	639	-	8,678	10,871
March	149	-	26	-	3,180	3,355
Total	9,787	-	3,893	-	59,009	72,689

SQUARE MILE

Yield.

The table below shows the number of pods harvested

TABLE 3

Period	Young Planted Cocoa				Mature Cocoa	Total
	Amelonado	Amazon	Trinitario	Hybrid		
January	23,623	15	190	371	31,939	56,138
February	1,048	286	-	56	3,226	4,616
March	1,043	-	-	-	2,399	3,442
Total	25,714	301	190	427	37,564	64,196

MAINTENANCE OF MATURE COCOA

The yields from experimental plots are given in the table below. With the falling off of the main crop the opportunity to remove rotting logs in the Amelonado Spacing Trial was taken while stunted and malformed trees in Blocks 3, 4 and 5, in the Amazon Spacing Trial were coppiced.

TABLE 4

No.	Plot	Experiment	Pods Harvested March Quarter 1961	Pods Harvested December Quarter 1960
1	A3	Clone Collection budded	1,062	92
2	A4	Comparison of Virus Strains	2,658	1,034
3	A6	Cover Crop and Fertilizer	14,821	14,500
4	B1	U.A. Multiplication	15,585	31,289
5	B2	U.A. Spacing and Pruning	24,097	29,136
6	B2(a)	U.A. Spacing Extension	3,594	8,102
7	D7	Amazon Tree Forming	1,723	1,856
8	G1	Uniformity Trial	12,295	76,031
9	G4	Amelonado Source Trial	1,125	9,241
10	G5	Factorial Fertilizer Trial	18,931	23,385
11	H1&L2	2nd Establishment Trial	5,931	28,564
12	H2	Virus on Amelonado Cocoa	796	3,258
13	H3	Virus on Amazon Cocoa	1,680	4,132
14	J1	Amelonado Spacing Trial	22,919	119,923
15	K1	Shade and Manurial Trial	19,697	57,244
16	P1	Early Bearing Experiment	3,938	155,593
17	P2	Amelonado Pruning Trial	2,301	6,802
Total			153,153	430,182

MAINTENANCE OF YOUNG COCOA

Routine maintenance of recent plantings was carried out. During a wet spell in March replacements of dead stands were effected in the Seed Garden.

TREE MORTALITY

Losses of cocoa trees due to swollen shoot and other causes in both Station Farm and the Square Mile are given in the table below.

TABLE 5

Month	Cocoa destroyed, Station Farm			Seedlings	Total
	Due to Swollen Shoot	Undiagnosed	Total		
January	40	2	42	11	53
February	22	-	22	6	28
March	37	-	37	10	47
Total	+99	2	101	27	128
	Cocoa Destroyed, Square Mile				
January	4	-	4	-	4
February	17	-	17	-	17
March	30	-	30	-	30
Total	51	-	51	-	51

Total for Station and Square Mile = 179 trees.

+Includes 19 contacts

PROPAGATION

Some 2,000 cuttings of various clones were planted, 80% of these were successfully rooted and hardened. Good progress was made in the re-building of the propagator.

CLONAL NURSERY

The number of suitable cuttings taken for rooting from the various clones were recorded at weekly and monthly intervals in the experiment to compare the cutting production potential of various West African Cocoa Research Institute Clones.

DISTRIBUTION OF AMAZON PODS

Eleven thousand F3 Amazon pods were sent to the Nigerian Western Region Department of Agriculture, two hundred were sent to Sierra Leone and seventeen hundred sold to staff members.

METEOROLOGY

Rainfall in inches and numbers of wet days for the quarter compared with the past 23-year means are shown in Table 6.

TABLE 6

Month	1961		Past 23-year means	
	Rainfall (ins)	Wet days	Rainfall (ins)	Wet days
January	0.09	3	1.55	3.7
February	1.89	2	3.51	6.9
March	2.74	11	6.10	12.1
Total	4.72	16	11.16	22.7

This has been the driest first quarter-year at Tafo since recording commenced in 1938 and some of the cocoa areas show signs of drought injury.

PATHOLOGY DIVISION

VIRUS RESEARCH

MECHANICAL TRANSMISSION OF COCOA VIRUSES

The mechanical transmission of an isolate of cocoa swollen shoot virus (CSSV) has been previously reported, (Quarterly Reports 57, 58 and 59). The isolate used (from Kofi Pare) was of the New Juaben type; in further work two distinct isolates of CSSV, one from Mampong and the other from Bosomuoso, which differ from and do not cross-protect against the Kofi Pare isolate, have been transmitted mechanically to cocoa from some alternative host plants (Table 7). A summary of the results on the transmission of an isolate of cocoa mottle leaf virus (CMLV) are also in Table 7.

TABLE 7

Rate of transmission of cocoa mottle leaf and swollen shoot viruses

Virus	Source Plant	Material	Inoculum	Test Plant	Transmission (a)	
					Individual Experiments	Total
Cocoa mottle leaf virus	A. digitata	Leaves	Slurry	Cocoa half-beans	1/25[c], 2/114[c], 4/37[b], 1/53, 1/50[c]	9/279
	H. barteri	Leaves	Slurry	Cocoa half-beans	1/47[b]	1/47
	T. bicolor	Leaves	Slurry	Cocoa half-beans	1/98[b]	1/98
	A. digitata	Cotyledons	Sucrose concentration	A. digitata	1/33	1/33
Cocoa swollen shoot virus isolate from Bosomuoso	B. brevicuspe	Leaves	Slurry	Cocoa half-beans	85/192, 3/100, 2/100, 3/100 4/100, 3/61, 4/55, 11/100	115/808
Cocoa swollen shoot isolate from Mampong	A. digitata	Cotyledons	Slurry	Cocoa half-beans	1/20[b]	1/20
	A. digitata	Cotyledons	Sucrose concentration	A. digitata	1/11	1/11
	B. brevicuspe	Leaves	Slurry	Cocoa half-beans	1/240, 2/200	3/440

a. Numerator indicates the number of infected plants and the denominator the number of test plants inoculated.

b. In these experiments the infiltrating solution (pH 8.0) contained 0.067 M phosphate, 0.05 M ethylenediamine tetraacetate and 0.01 M cysteine.

c. In these experiments the infiltrating solution (pH 8.5) contained 0.1 M phosphate and 0.1 M cysteine.
In the other experiments the infiltrating solution (pH 8.5) contained 0.1 M phosphate and 0.1 M thioglycollic acid.

Transmission rates are low but it is hoped that these can be improved when concentrated inocula can be prepared in the ultra-centrifuge. The ultra-centrifuge has arrived and its installation awaits the arrival of the service engineer.

MINISTRY OF AGRICULTURE 'CAPSID YIELD RECORDED UNITS' NOTES ON YIELD TRENDS SINCE 1954

During 1959 analyses were made on five years' crop data (1954-58) from the Ministry of Agriculture 'Capsid Yield Recorded Units' with the primary object of estimating losses from black-pod disease in Ghana. The main results from this survey have been given in Quarterly Reports 56 and 57 and the Annual Report, W.A.C.R.I, 1960. Following these results a fungicide-spray trial was laid down on 16 of the 23 units in 1960. Because of the yield increases resulting from capsid control, as exemplified by the data for 1954-1958, an interest was retained in the yield trends over all the units, during 1959 and 1960, and the recent summaries are reported here.

Figures for 'Immature Ripe' pods classified on the standard, field-record sheets are excluded because these are largely fruits greater than 3 inches in length lost from physiological wilt and do not contribute to potential crop. Similarly, figures for 'Rodent Damaged and Empty Pods' have been left out. Losses from rodent attack from 1954 to 1960 have been so negligible (Table 8) it is unlikely that rodent damage will ever be considered sufficient to warrant control measures, and the numbers of pods affected should not be considered as potential crop.

TABLE 8

Region \ Year	1954	1955	1956	1957	1958	1959	1960	7-year Average
Eastern	2.1	2.1	1.8	2.2	4.5	2.9	2.8	2.7
Ashanti	1.3	2.1	2.5	1.9	2.6	1.4	1.4	1.9

Table 8 Rodent damaged pods as a percentage of total pods.

Table 9 shows the potential yield of lbs. dry cocoa per acre (where 12 pods = 1 lb.) from all the "capsid treated" plots of the 11 Eastern Region and 12 Ashanti Units for each of the years 1954 to 1960. At the end of 1958,

TABLE 9

Year / Region	1954	1955	1956	1957	1958	1959	1960
Eastern Region	155	421	581	513	562	793	830
Ashanti	391	406	730	704	732	918	944
Eastern Region and Ashanti	273	414	681	604	647	856	887

Table 9: 'Capsid Yield Recorded Units' - capsid treated plots - potential yield in lbs. dry cocoa per acre.

when the data was last summarised, it was considered that yields had virtually reached their maximum in 1956 and that the variations in crop over the three years 1956 to 1958 represented seasonal variations around the maximum. However, with the 1959 and 1960 data it now appears that the benefits of capsid control are still increasing after 7 years.

Table 10 shows the same data used for Table 9 with two corrections applied. The figures are estimates

TABLE 10

Year						
1	2	3	4	5	6	7
211	428	524	485	613	725	772

Table 10: 'Capsid Yield Recorded Units' - capsid treated plots - estimated actual yield in lbs. dry cocoa per acre.

of actual yield after excluding all diseased, unripe pods harvested plus 43 per cent of the diseased ripe. The figure of 43 per cent is the best estimate, so far, of the proportion of diseased, ripe pods completely destroyed on a monthly harvesting schedule (see black-pod control trial below). Six of the 23 units were not started (and sprayed) until 1955. The data for these units has been moved back one year and the yields expressed as averages for each year from the commencement of spraying. Table 10 still shows the general pattern of increase as in Table 9 with good estimates of the actual yields in lbs. dry cocoa per acre. Whether or not these increases in yield are approximately linear is difficult to say. There are bound to be seasonal variations in crop which are independent of capsid control. For example, 1956 was one of those exceptional years (260,000 tons) for Ghana production in general, which could explain the high yield for this year in Tables 9 and 10 compared with 1957 and 1958. Using the data in Table 10 the average increase in crop for the last 6 years compared with year 1 is in the order of 180 per cent, and 255 per cent over the initial yield, if the last two years' yields are averaged.

The increase in yields over 7 years may result from a continued general improvement in trees which had been severely blasted by capsid attack, in many instances the dieback extending to the main trunk. Another suggestion is that regenerated chupons which are now six years old have begun to make an additional contribution to the yield of the older parts of the trees. Not all the cocoa in Ghana was so severely damaged as these experimental units but very large acreages were. Whatever the reason for the yield increases it does appear that the estimate, at the end of 1958, that the cocoa crop might be doubled by capsid control measures alone was a conservative one.

A report on these yield trends has been sent to the Chief Cocoa Officer, Ministry of Agriculture. The records to date, which now include 7,600,000 classified pods continue to be very well kept by the Ministry staff.

BLACK POD FUNGICIDE CONTROL TRIAL

Details of this experiment are given in Quarterly Report No.57. It was provisionally agreed with the Ministry of Agriculture that the trial should continue unchanged for two seasons. Nearly all the records for the first year, 1960, have been collected and summarised. An interim analysis of treatment effects on the incidence of black pod disease has been made in which the 1960 records have been corrected by three years' pre-treatment data. The treatment means (black pods as a percentage of total pods), adjusted where necessary, are given in Table 11. The Treatment A effect is highly significant at P = 0.01.

TABLE 11

		No spray
Treatment A	20.4	28.9
Treatment B	15.5	23.1

Table 11. Adjusted treatment means (black pods as a percentage of total pods).

but the B effect escapes significance (though barely) at the 5 per cent level of probability.

From the above results Treatment A has protected 8.5 per cent of the crop from black pod and Treatment B a suggested 7.6 per cent. These proportions represent a 30 and 33 per cent reduction in proportion of crop attacked by 'black-pod.' Better control than this had been hoped for in the first year of spraying. However, the most interesting point is that Treatment A (6 applications of Perenox concentrated before and during the mid-crop out-break on immature pods) has given better results than Treatment B (10 applications of Perenox over the whole season). Treatment A was the spray schedule of primary interest in this trial and it has been suggested to the Ministry of Agriculture that it should be given a complete test by continuing the trial for a further year.

Estimates of loss depend on the proportion of diseased, ripe pods which are completely destroyed on a specific harvesting schedule (in this case, monthly). Counts taken during 1958 on 16,000 diseased, ripe pods harvested on the Eastern Region Units led to an estimate that 43 per cent of the diseased, ripe pods were completely discarded.

In 1960 counts on 100-pod samples of diseased, ripe pods were made on all the black pod trial plots to try and increase the accuracy of this estimate. When all this data has been received, the first year's data will be analysed with respect to loss of crop from pod disease as opposed to incidence of the disease dealt with above.

BLACK POD DISEASE

MECHANISMS OF RESISTANCE AND TOLERANCE TO PHYTOPHTHORA PALMIVORA

Work has continued on evaluation of criteria to provide laboratory tests for indicating resistance and tolerance to black pod disease (cf. Quarterly Report No.60). A survey is in progress of polyphenol and polyphenoloxidase activity of 'resistant' and 'susceptible' selections, comparing these with that of unselected Amelonado controls, but insufficient data are available at present to indicate any major differences.

In further tests with aqueous extracts of internal and external endocarp tissues, external endocarp tissues of unripe pods of U6, ICS1, 02 and R15 produced a marked inhibition of zoospore germination, as did extracts of similar tissues of ripe pods of ICS1 and 02. Internal endocarp extracts of the same selections, with the exception of ripe pods of ICS1, and to a lesser extent R15, also showed marked inhibition of zoospore germination.

Preliminary tests were also made on resistance of ripe pods of a few selections to spore infection. Pods were left overnight at c.6°C and then left for 15 mins. to accumulate condensation before spraying with spore suspension. Unselected Amelonado pods were usually included as comparative controls. The pods were incubated in humid chambers for 7 days and percentage infection recorded; results are summarised in Table 12.

TABLE 12

Selection	Proportion infected	
	Selection	Amelonado
U6	0/12	*
R15	12/12	*
ACU85	10/10	8/10
B3	10/10	8/10
A56	8/10	8/10

Table 12. Infection of cocoa selections with P. palmivora spore suspensions.
* Not tested.

ALTERNATE HOSTS OF P. PALMIVORA

A number of diseased plants from the area around the black pod resistance trial at Obomeng were tested for infection by P. palmivora. These were Blighia welwitschii, Capsicum annuum, Culcasia scandense, Marantochloa inaequilatera, Randia (?) sp., Rauwolfia vomitoria, Vitex grandifolia, and a fern A diseased sample of Millettia zechiana from Ampam was also tested. P. palmivora could not be isolated from any host. Two species of Mimusops from Aburi, M. elengi and M. commersonii were found to have fruits heavily infected with Trachysphaera fructigena, and are new host records for the fungus in Ghana.

A GALL DISEASE OF COCOA IN GHANA

Isolates of Calonectria rigidiuscula (Berk. & Br.) Sacc. which are infective to cocoa beans have now been recovered from 7 tree galls. A limited number of inoculations into flowering cushions and pod stalks on trees have been made using culture B151 (see Quarterly Reports Nos. 59 and 60). Galls are appearing on 1 pod stalk and 2 cushions confirming that this isolate will induce galls on mature trees as well as on seedlings.

Results of the experiments into the etiology of this gall disease in Ghana will now be prepared for publication in detail.

BOTANY DIVISION

PLANT BREEDING

STUDIES OF BLACK-POD INCIDENCE, AND OF RODENT ATTACK
Trinidad Introductions Area

Data collected over 3 seasons (1953-56) has been studied for a small group of plots of Amazon parentage in the Introductions area. Crosses between Nanay parents were relatively heavily attacked by black-pod (Na32 x Na31 and Na33 x Na34), while crosses of Nanay to Parinari were much less heavily attacked (Na32 x Pa7 and Na32 x Pa35). The cross Nanay 34 x Iquitos 60 was attacked as heavily as the Nanays but the cross Nanay 33 x Iquitos 60, growing alongside, was quite lightly attacked. This would appear to indicate that Nanay 34 carries a factor for high black-pod susceptibility which is not present in Nanay 33 or in Iquitos 60. The same factor would appear to be present in either (or both) Na 32 or Na31.

Tree to tree variation was studied and this suggested that all progeny of Na34 do not carry this factor for susceptibility, and that T85/799, which has been used as a parent in the Series II hybrids with good results, is one of those that do not.

No tree of Nanay 32 x Parinari 7 (T60) was heavily attacked, though some of the progenies of these trees in Series I trials are proving relatively susceptible. A few trees of T63 (Nanay 32 x Parinari 35) were heavily attacked.

In this area rodent attack appears to have been heavy on the Nanay x Parinari crosses while there was little attack on the Nanays. This observation appears to be supported by the data from the Series I trials.

The Series II trials.

Data from the current season is not yet complete, but certain patterns are evident. For black-pod, varieties WE6 and WAE11/EA3 have had least losses, while heaviest losses were on WEB1 and WBE3. An analysis of the percentage losses of the four varieties common to the four heaviest yielding trials (Apedwa, Fumso, Buaku, Pankese) showed the varieties to differ significantly at P = 0.01, WBE3 and WBE4 being significantly more heavily attacked than WE6 and WAE11.

Varieties WE6 and WAE11 have as a parent T85/799, mentioned above.

For rodent attack, WE4 is most heavily attacked followed by WBE6/EB3 and WEB1, attack being lightest on WE6, WAE11/EA3 and WBE4. Percentage attack on the five varieties common to Buaku, Apedwa and Fumso trials differed significantly at P = 0.01, WBE6 being significantly more heavily attacked than any of the others (WBE3, WBE4, WE6, WAE11), and WAE11 being significantly less attacked than WBE3 and WBE4.

Yields: Series II trials

Data for the season is not yet complete, but on that at present available it is clear that outstanding performances are being obtained at some sites. The Apedwa, trial, planted in 1956, has given an average yield of about 900 lbs. dry cocoa per acre, and the Fumso and Buaku trials planted in 1957, between 700 and 800 lbs./acre. At Apedwa variety WAE11 has given about 1200 lbs, at Fumso varieties WBE3 and WBE6 about 1100 lbs., and at Buaku varieties WBE2, WAE11 and WBE6 over 850 lbs

Studies on 1st P.T.A.

/See Posnette, A.F., Emp. J. exp. Agric., 19, 242, 1951./

Variation in the mean weight of cocoa per pod between the 29 Amelonado varieties in the 1st PTA was very small but yet was statistically significant over the three seasons 1948-9 to 1950-51, ranging from 3.13 ozs. of wet cocoa per pod to 3.57 ozs. per pod. There was no apparent difference between the three groups of Amelonado, those from Aburi, from Asuansi and from Kpeve, in this respect. The two non-Amelonado types N38 and E1 both had significantly

heavier pods than any of the Amelonados.

General recording of this trial was discountinued at the end of the 1950-51 season, though selected varieties were recorded to the end of the 1953-4 season and again in 1957-8. Recording of a small part of the trial (3½ acres) was recommenced in 1959-60, but the cocoa was not weighed. Yields are now difficult to assess at all accurately as substantial numbers of the original trees have been lost due to various causes, and remaining trees have in many cases expanded to close gaps in the canopy so that the original spacing has in effect been modified. Yields of Amelonados however for the 1959-60 season are in the order of 800-1100 lbs/acre, (based on 1949-50 season wet weight and 1959-60 pod nos.) The highest yielder is the non-Amelonado variety E1 with about 1300 lbs/acre. Variety P4/9 (from Kpeve) appears to be the best yielding of the Amelonados, followed by A196 (Aburi) and S53 (Asuansi). Again in yield there is no clear difference between the groups of Amelonado selections from the three stations. The proportion of the total crop borne upon the trunk varied from 37 to 52 per cent, again with no apparent difference between Amelonados from the three sources.

Black-pod incidence on the Amelonados varied from 6% to 16%, the non-Amelonados E1 and N38 having 14% and 5.4% respectively.

The incidence of rodent attack on pods varied from 2.4% to 8.2% on the Amelonados, being similar on the three groups; on E1 it was 7.6% and on N38 8.5%.

Amelonados derived from Aburi and Asuansi might be expected to be similar because the Asuansi plots were planted with seed from Aburi, but it would not have been surprising if the Amelonados from the formerly German station at Kpeve had shown differences as the seed was probably from a different source.

Over the period 1948-9 to 1953-4, in which detailed records were kept on four Amelonado varieties and the two non-Amelonado varieties, there was marked year to year fluctuation. There may be some association between this observation and that by Posnette (loc. cit) that this variety appeared better relative to Amelonado in the poorer plots of the 1st PTA than in the better plots.

These observations confirm that the Amelonado selections Kpeve (P) 4/9, Asuansi (S) 72 and Asuansi (S) 84, used in the production of the Series II hybrids are still regarded as the most suitable for further breeding work.

PLANT PHYSIOLOGY

GREENHOUSE

The Greenhouse built for mineral nutrition work was completed during this quarter. Preliminary data show that with the forced draft system in operation greenhouse temperatures are a little above outside temperatures during the hottest period of the day.

The rain collection and storage equipment is functioning satisfactorily and should supply the estimated daily requirement of 100 gallons without difficulty. Resin columns are in use to purify water for experimental purposes.

Sand to be used for macronutrient treatments is put into large (40 gallon) stoneware jars glazed inside and out, and soaked in cold 5% HCl and 0.5% oxalic acid for a week. The sand from the Square Mile at WACRI has proved to be very pure.

In the absence of a sand-digester, refinement of the cold acid treatment described above is being made to provide sand of higher purity for use in micronutrient experiments.

COPPER SPRAY TRIALS

A copper spraying trial has been superimposed over the spacing trial on Block J1. Spray is applied at four-week intervals. The purpose of the trial is to determine if applications of copper will give an increase in yield and to compare copper as a nutrient ($CuSO_4 5H_3O$ 0.5%) and copper as a fungicide (Perenox 1%).

The yield results after one year, compared with two years pretreatment data, show no significant effect of treatment.

ENTOMOLOGY DIVISION

NURSE SHADE V. NO SHADE EXPERIMENT

Larvae of Earias biplaga became more numerous in January; the average number per tree rising to a maximum of 0.95 in the unshaded unsprayed plots and to 0.05 in the shaded unsprayed plots. The average number

of larvae per tree in the unshaded unsprayed plots was the highest recorded since April, 1960. During the previous quarter the numbers of Earias larvae per tree averaged 0.25 in the unshaded unsprayed plots. In February Earias larvae became fewer and by the end of the month the average number per tree had dropped to 0.02 in the unshaded unsprayed plots and to nil in shaded unsprayed plots. The average number of 0.02 larvae per tree was the lowest recorded for unshaded unsprayed plots since recording began in February, 1960. These low numbers corresponded with very low numbers of flush leaves present during February. During March the number of Earias larvae increased and by the end of the month the average number per tree in the unshaded unsprayed plots was approximately 0.5

CAPSID STUDIES

JOINT WACRI/DIVISION OF AGRICULTURE CAPSID CONTROL TRIALS

Application of Dipterex at 1 lb. actual and of Lebaycid (S.1752) at 45 ccs. actual in 5 gallons of water per acre was made in January and February by mistblower to plots at Kwahu Tafo. These plots, previously used for Endrin and Sevin trials, were reallocated on the basis of equivalent existing capsid damage. Comparison of efficiency will be made against a standard Gammalin 20 application.

MEALYBUG STUDIES

JOINT WACRI/DIVISION OF AGRICULTURE ANT/MEALYBUG CONTROL TRIALS

Methods of Application and Formulation Trials

Fornightly ant and mealybug population records have been carried out throughout the quarter and the gradual rise of mealybug populations continues for all treatments. Figures for Eulophonotus damaged trees from the commencement of the experiment and totalled to the end of the quarter are:

Treatment	(1)	(2)	(3)	(4)	(5)
(Quarterly Report No. 54)	92	137	40	108	1

Chlordane and Heptachlor Trial

A report was made of the object and scope of this trial in Quarterly Report No.60. Application of 1 lb. actual toxicant in 20 gallons of water per acre was made to the trunks of cocoa and forest trees by motorised knapsack mistblowers in February and March. The Koransang plot was treated with Heptachlor and the Nankese unit with chlordane. Pre-treatment figures for ant populations based on individuals, columns and active nests on labelled trees and of mealybug populations, Tragocephala, Eulophonotus, stem-webber and Marmara damage on random transects through the plots have been obtained. Records are being made at fortnightly intervals by the same teams which carried out population assessments on the Methods of Application and Formulation plots.

ANT/MEALYBUG POPULATION STUDIES

The survey of the various species of ants and mealybugs at the four centres H4, E1, N9 and K2 on W.A.C.R.I. continues (see Quarterly Report No.59). The data collected during the past year reveal that the balance between mealybug populations at the unsprayed centres and the sprayed centres are quite different (see Table 14). There are also differences in populations between sprayed plots which appear to show some correlation with the amount and type of vegetation.

TABLE 14

Mealybug spp.	Mean mealybug populations for 360 trees per month, from one year's sampling at four centres			
	UNSPRAYED H4	SPRAYED E1	SPRAYED N9	SPRAYED K2
Pl. njalensis	2290.5	437.2	903.7	127.1
Pl. citri	87.0	132.3	212.9	117.2
F. virgata	18.5	323.3	173.0	419.1
Ps. bukobensis	3.0	48.9	149.0	38.5

POLLINATION STUDIES

Daily recording to estimate the percentage of flowers which set and which develop into ripe pods has started on 207 trees in D1. These data will be of use in determining the effect of different insecticides upon pollination rate.

MINOR PESTS

MARMARA STUDIES

Several methods are being used to estimate the length of the stages of the life history of Marmara sp. (the cocoa pod-husk miner).

CHEMISTRY DIVISION

SOIL FERTILITY

FIELD EXPERIMENTS

The crop year finished during the quarter. The bulk of the crop had been harvested by the end of 1960 on all the fertiliser trials.

Amelonado Shade and Fertiliser Trial

The final yields for the season have again been spectacular and are shown in Table 13.

TABLE 13

Shade and fertiliser yields 1960-61

TREATMENT	lb. of dry cocoa/acre	TREATMENT EFFECTS		% INCREASE
SHADED NO FERTILISER	750	SHADE REMOVAL	WITH FERTILISER	+247
SHADED FERTILISER MIXTURE	1,031	EFFECTS	WITHOUT FERTILISER	+251
UNSHADED NO FERTILISER	2,629	FERTILISER	WITH SHADE	+ 37
UNSHADED FERTILISER MIXTURE	3,577	EFFECTS	WITHOUT SHADE	+ 36

The condition of the canopy in the unshaded cocoa receiving no fertiliser had earlier suggested that the expected decline in yield of these plots had commenced. However the relative yield was higher than last year. The fertiliser response obtained under shade, 37%, is closely similar to that where the

shade has been removed, 36%. The response to shade removal, again very high, is about the same whether fertiliser is applied or not, namely 247% and 251% respectively. The figure of 3,577 lb. of dry cocoa per acre is the highest yield, from any type of cocoa, yet recorded at Tafo.

The irrigation of a portion of this cocoa has been continued and is probably responsible to some extent for the high yields.

Amazon Shade and Fertiliser Trial

The cocoa trees on this experiment, planted in June 1959, have made good growth and the first pods are forming on some trees. The temporary tree-cassava shade was removed in January, 1961 and the inter-row vegetation was cut back hard because it was starting to compete with the cocoa for light and nutrients. The exceptionally severe dry season which ensued caused fairly serious defoliation and die-back to the cocoa, but there have been very few deaths and it is hoped that the trees will make rapid recovery when the rains commence.

Joint WACRI/Cocoa Division Trials

The records from these experiments are not yet available. The first year results from the series of "Phosphate" experiments will be presented in the Annual Report.

New Experiments

Four new experiments on Cocoa Division Stations have been designed to investigate the Nitrogen and Phosphate responses and their interaction. The plots have been prepared in the field and will receive their first dressings of fertiliser in April this year. At Tafo, two new experiments to determine the value of fertilisers at the time of planting and in the cocoa's early years have been designed and the land prepared for planting in June this year.

Irrigation

The pilot irrigation trial, which has been going on for two years, has been completed, and will be reported in detail elsewhere. The large irrigation trial is still in progress, and more data is required before conclusive results may be obtained.

LABORATORY STUDIES

The monthly leaf analysis on the Shade and Manurial Experiment (Block K1) was concluded. Ripe pods (beans and husks separately) from plot A6 were also analysed in order to assess approximately the magnitude of the drain of nutrients, especially

K, from the soil.

The soil phosphate studies continue. The period of incubation for mineralisation of organic-P is being extended to 72 days. The effect of added N and P on the mineralisation of organic-P is also being examined.

Analyses of soil samples from the plots at Atwere and Nkawie, Ashanti and WACRI Blocks H1 and L2 have shown that P applied as rock-phosphate remained longer in the more soluble form of calcium-P whilst that of super-phosphate was converted largely into iron and aluminium-P. Leaf analyses also gave indications that these phosphates lower the uptake of iron. These studies will be continued.

Laboratory investigations are being carried out on the effect of broadcasting of fertilisers on the thick leaf litter in field experiments. It is hoped that the results will help to interpret the data on the experiment on the former soil exposure site on which has been superimposed the following new treatments: bare soil, litter only, fertiliser only, and litter plus fertiliser.

Investigations were commenced on the various soil series under forest (or secondary forest) and under cocoa to assess some of the chemical and biological changes which occur when the forest is clear-felled and cocoa is planted in a forest.

Pot Experiments

A pot experiment was commenced to compare the effects of different sources of P (rock - and triple-superphosphate) and N (urea and sulphate of ammonia) on the growth of and uptake of native micro-nutrient by young cocoa seedlings.

The pot experiment referred to in Quarterly Reports 58-60, in which soil pH and manganese uptake were being investigated, was harvested on 13th January, 33 weeks after planting. The chief results may be summarised as follows:

(a) The application of nitrogen as ammonium sulphate at the rates 0.1g, 0.3g and 0.9g N per plant per month resulted in final soil pH's of 4.8, 4.2, 4.1, compared with pH 7.5 for untreated controls.

(b) The leaf concentration of manganese was much higher where the pH had been lowered by ammonium sulphate. Control plants averaged about 250 ppm whereas plants receiving 0.3g N per month contained about 2000 ppm. Applications of manganese sulphate at the rate of 15 mg Mn per plant per month did not result in a higher leaf concentration than in the controls nor

did it effect the soil pH.

(c) The ammonium sulphate treatments gave final plant dry weights 108%, 134% and 79% greater than the controls.

The results of this and all previous pot experiments carried out with the concrete tank layout since May 1958 are being studied in detail and prepared for publication.

IBADAN STATION

VIRUS RESEARCH

VECTORS OF NIGERIAN COCOA VIRUSES:

It seems important for the transmission of cocoa swollen shoot virus (Offa Igbo 1959) by Aphis gossypii Glover, that many aphids are made to feed on a limited leaf area so that obvious damage ensues. Aphids do not seem to become infective when allowed to spread over large areas. This could explain why aphids fed on infected seedlings of Adansonia digitata L. did not transmit the virus because only few aphids will settle even when large numbers are confined in leaf cages.

No further transmissions of cocoa necrosis virus by mealybugs have been obtained.

EXTRACTION OF NIGERIAN COCOA VIRUSES:

The reason why virus particles are not always released from macerated tissue is still unknown. Samples of extracts have invariably been tested for the presence of proteins. These indicate that some recent extracts have contained more protein than others made previously and also possibly some new fraction which was previously absent or too dilute to be indicated by these tests. The results of infectivity tests for these extracts are still incomplete.

VIRUS TOLERANCE:

Screening of available breeding material was completed during the year, and a programme of hand-pollinations was begun to produce material with which to investigate segregation of tolerance within tolerant types, and the inheritance of characteristic reactions to the Ikire virus. A series of hybrids between tolerant Nanay-Iquitos Amasons and tolerant Trinitarios has been produced, and these will be compared with selected

W.A.C.R.I. Series II hybrids for vigour and tolerance. These investigations will comprise several field experiments which will be planted at Gambari Experimental Station during the coming wet season.

Virus Tolerance Field Trials at Alakia: Growth data from the first tolerance experiment have been sent to the United Kingdom for analysis on an electronic computer. Symptom records are now complete, and a study of segregation of reaction to the Ikire virus is proceeding. From available data it appears that inheritance of tolerance factors is not under simple genetic control.

Effect of Selected Nigerian Virus Isolates on Three Cocoa Types: Healthy buds of C6 (Amelonado), C40 (Nanay-Parinari) and C77 (Nanay-Iquitos) were grafted onto healthy Amelonado seedlings. Groups of twenty budlings of each variety were infected with virulent isolates of Ikire, Offa-Igbo, Olanla, Abaku, and cocoa necrosis viruses. The necrotic reaction of Parinari types to infection with the Ikire virus was shown in this test by C40, but this variety did not produce necrotic symptoms when infected with the other isolates of the swollen shoot complex. Some budlings of C6 showed similar necrotic symptoms with Ikire virus and it may be that this reaction is a characteristic of this virus and is only produced in cocoa types which are particularly susceptible to it. Both Amazon varieties were more tolerant to infection with all isolates than Amelonado, though C40 was more severely affected by the Offa-Igbo isolate than C77. The three varieties showed the necrotic symptoms typical of infection with cocoa necrosis virus, though the Amazon types continued to grow satisfactorily whereas most Amelonado budlings were killed at an early stage. Further experiments of this nature are being continued.

ENTOMOLOGY

SHOT-HOLE BORER STUDIES:

Gambari Shot-hole Borer Experiment 1: The marked association of attack by Xyleborus morstatti Hag. with cocoa seedlings under palm frond shade (noted in the previous Quarterly Progress Report) rather than to those unshaded, has persisted.

There has been no very great increase in the numbers of attacks since December; at the end of March only 16 attacks had occurred on the unshaded plots out of a total of 119.

Of the 182 seedlings which had died in the area 172 were in the unshaded plots. None of these deaths was clearly attributal

to shot-hole borer attack.

Observations on Alakia IV: This area of seedlings was planted by the Agronomist in October, 1960, to observe the effects on seedling growth of bare soil, over all mulch and alternate row mulch on shaded and unshaded plants. In addition all plots were split for watering and no-watering.

An estimate of borer incidence was made at the end of February when it was found that 86.8 per cent of seedlings beneath the shade had been attacked as opposed to only 8.6 per cent of unshaded plants. There was little apparent difference in degree of attack between any of the other treatments.

It seems clear from this, and the above experiment, that X. morstatti shows a strong preference for shaded plants. In view of the fact that in both these experiments the physical nature of the shade was similar (palm fronds) it is not possible to discount the effects of the shade itself as an attractant, nor is it yet possible to dissociate the effects of shade from those of temperature.

Araromi Shot-hole Borer Control Experiment: The fifth and final monthly application of insecticide (to all six treatments) was made early in March. No further applications will be made as there has recently been little change in borer infestations and past experience indicates that populations are unlikely to increase again for at least six months, by which time the plants will be scarcely susceptible.

By the end of March the percentage of plants attacked was 15.2; this is only a small increase on the figure of 12.5 given for December, (see previous Quarterly Progress Report). There have been no clear differences in degrees of infestation between any of the treatments.

Relationship of Intensity of Attack to a Source of Infestation: As the proportion of shot-hole borer galleries in cocoa seedlings in which breeding actually takes place is very small it is reasonable to assume that the seasonal pattern of attack to cocoa is related to population fluctuations on other host plants. The wild host plants of X. morstatti in Nigeria are not definitely known but amongst cultivated plants Coffea canephora (Robusta coffee) is a favoured species upon which breeding occurs throughout the year.

In order to investigate the range of movement of adult beetles from a source, a coffee plot at the Gambari Forest reserve was used as a focus, lines of cocoa seedlings 700 feet

long being arranged at right angles to it. The results, which are not yet complete, indicate that after 200 feet from a source of infestation attack to cocoa seedlings is negligible. This conclusion is reinforced by data from elsewhere. The Gambari Shot-hole Borer Experiment I is a rectangular plot with one of its short sides adjacent to an area of secondary forest, whilst on its two longest sides it adjoins mature cacao which is not susceptible to shot-hole borer attack. On the edge most distant from the forest area it is adjacent to a plot of similar cocoa seedlings planted at the same time. The distribution of attacks across these two plots of seedlings indicates that incidence declines with distance from the forest areas, which presumably contains wild host plants of X. morstatti. At 200 feet from the forest there are only 0.02 attacks per plant whilst in the nearest 100 feet incidence varies from 0.06 to 0.09 attacks per plant. At 450 feet the incidence is down to 0.002 attacks per plant.

Further evidence comes from Alakia I. in data collected from January to March in 1960. Here, one side of the plot is adjacent to a main road whilst the other three sides are bounded by secondary scrub land interspersed with food farms and small areas of cocoa. The results are not as clear cut as for the Gambari experiments, but incidence appears to decrease towards the road.

MINOR PESTS OF COCOA

Observations on the incidence of various minor pests of cocoa (first reported in the previous Quarterly Progress Report) on the Gambari Shot-hole Borer Experiment I. have continued.

Throughout the dry season there has been a progressive steady decline in the numbers of Lepidopterous larvae. In November, 1960, 148 were recorded in December 53, in January 1961 35, in February 12 and in March only 9. During the same period the percentage of plants flushing and the mean numbers of leaves per plant have similarly declined, though it is not suggested that it is necessarily the direct effect of reduced food supply that is the cause of this decrease in numbers of caterpillars.

Other pests have fluctuated in quite different ways. Since the commencement of these observations in October, 1960, each of the ones recorded has had a population peak at a different time. Aphids (Toxoptera aurantii(Bat.)) reached their peak in November (14.6% plants in shaded area infested), and by January had completely vanished. The peak of psyllid (Mesohomotoma tessmanii (Aulm)) infestation was in January

(44.6% of plants in shaded area infested) and populations had fallen very low by March. With thrips (Selenothrips rubrocinctus Giard.) the population peak has been less emphatic with equal numbers (6.7 and 6.4% in shaded area) of plants infested in January and February. Due to the difficulties of distinguishing mealybug species in the field, especially in their nymphal stages, all mealybugs with the exception of Ferrisiana virgata (Ckll.), have been grouped together. Populations of F. virgata have risen more or less steadily since the inception of observations (to 12.8% of plants in March), and similarly, the peak of mealybug populations has probably yet to occur; populations of these were at their lowest in January.

No single one of these six recorded groups has yet shown a clear association with the pattern of flushing and mean leaf numbers and presumably other more important factors than these are involved in their fluctuations.

AGRONOMY

NURSERY TRIALS:

The trial described in the last quarterly report has continued, and all the beans have now been sown. Germination was very high, over 95% with two exceptions; there was only 89% germination in the beans sown in November with no shade, and 82% germination from the January sowing in one plot under heavy shade. This last result is attributed to one particular planter, whose non-experimental sowings were also poor. Some plants that had germinated have subsequently died back, and it will not be possible to give a final assessment of survival in the nursery until the trial is planted in the field.

Records have been taken at four-weekly intervals of height and leaf number. These have shown consistent differences between the shade treatments and, in the unshaded plots only, between the frequencies of watering. Type of pot has not had any systematic influence, and such slight effects as have appeared have tended to favour the polythene pots rather than the 'whalehide' type. Inevitably, there are differences between times of planting, and these have modified the effects of shade. At the first and last times of planting, November and February, which were both quickly followed by severe harmattan conditions, the unshaded plots were relatively poorer than at other times. Mean values per plant for height in inches and leaf number in March, 5 weeks after the last planting date and thus 17 weeks

after the first, were as follows:

Time of Planting.	No Shade		Light Shade		Heavy Shade	
	Infrequent watering.		Frequent watering.			
	Height.	Leaves	Height.	Leaves	Height.	Leaves
November	8.4	15.0	10.8	18.8	13.6	15.5	12.7	13.3
December	7.6	13.5	9.4	17.5	10.4	11.9	9.9	10.0
January	4.7	8.0	6.0	8.6	7.5	8.8	7.6	7.4
February	1.6	1.8	3.7	4.0	6.3	4.6	7.1	4.5

5% significant difference between the two frequencies of watering with the same shade treatment and time of planting: 1.10 for height and 1.61 for leaves.

5% significant difference between two shade treatments at the same time of planting: 0.76 for height and 1.76 for leaves.

Observations suggest that the leaves on the unshaded plants, though very numerous, are so small as to make the total leaf area less than under the light shade; leaf measurements will be taken on selected plants at the time of planting in the field. Symptoms of deficiencies of iron and zinc have appeared in the older plants, these being most marked on the more vigorous of the unshaded plants. The iron deficiency was the more severe, and routine foliar sprays of an iron chelate are now being applied.

Other trials have also been started, making use of concrete beds. In these beds, the idea of which was adapted from those in Tafo, the pots stand in about 3 inches of water and there is no need for any top watering. Early results have not been very encouraging, one possible explanation being that the beds are on an exposed site with no side shade, and a modification to the beds may be needed. A test showed that, at least for plants standing in water, better germination was obtained by planting the beans only just under the surface than by planting them 2" deep. After a fortnight, in plots receiving light shade 99% germination was achieved with shallow planting against 66% with deep planting; in unshaded plots 85% of the shallow planted beans and 53% of the deep had germinated. A further trial has been started to compare the growth of plants germinated in the concrete beds with that of plants germinated with top watering and transferred after a fortnight to standing

water.

STATISTICS

A visit to Tafo provided a stimulus to the examination of the results of the new spacing trial at Gambari, and this is in progress. Results from several capsid and virus trials are being examined in an effort to find which factors are of most importance in determining subsequent cropping.

The detailed planning of this year's planting programme at Gambari is in hand, while advice has continued to be given at the request of officers of other departments on Moor Plantation.

ESTABLISHMENT OF COCOA ON CLEAR-FELLED LAND IN NIGERIA

The advantages of mulching young cocoa have been demonstrated in Ghana (Cunningham and Smith, 1961. Trop. Agriculture, Trin. 38, 1961) and in Nigeria (Longworth, Rep. W.Afr. Cocoa Res. Inst. 1959-60). Although the former workers consider that the high cost of the operation may render it uneconomic, this may not be true in Nigeria, where establishment is often a critical problem. However, it seems desirable to reduce mulching costs, and applying mulch between alternate rows only, a method suggested by Haarer (Haarer A.E., Modern Coffee Production, 1956) was compared with a complete mulch cover in a trial planted at Alakia near Ibadan in November, 1960. Bare soil was included as a third treatment as this had given good results in a previous trial at Alakia. The present experiment consisted of four replicates of two treatments, palm-frond shade and no shade. Each of these main plots contained complete mulch, alternate-row mulch and bare soil as sub-treatments. These sub-plots were further divided for additional watering and no watering. Each main plot contained 180 F3 Amazon seedlings planted at four feet by four feet spacing. The trial was planted in November, just before the dry season, so that the effects of the treatment would be adequately tested. By February, 1961, it was observed that growth of the seedlings with complete mulch cover and alternate-row mulching were both superior to bare soil under shade. Without shade both mulch treatments were superior to bare soil, but the complete mulch cover was slightly better than alternate-row mulching. All three sub-treatments were better under shade. There was a beneficial effect of watering

in all treatments.

The relatively poor growth in the bare soil treatment should be compared with the good growth obtained in bare soil in a previous experiment at Alakia (Longworth 1960) which was planted in June 1959, some five months before the dry season. After the present experiment was planted rain fell on only four days between November 1960 and February 1961. However by February few seedlings died, and differences in survival were negligible.

SEKA.